1504

INSTRUCTIONS AND APPLICATIONS

Deviation Bridge Type 1504

Adapted for the checking of resistors, capacitors and inductors, in industrial production and laboratories.

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Deviation Bridge

Type 1504

Reprint June 1961

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Description.

General.

The Deviation Bridge is a measuring bridge for testing resistors, capacitors and inductors.

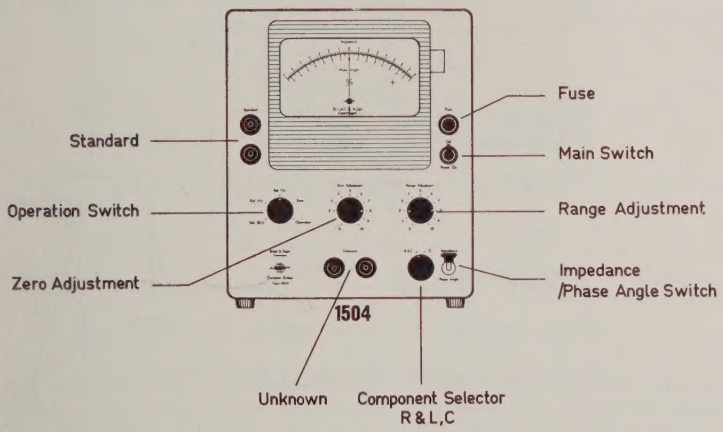


Fig. 1. Drawing of the Deviation Bridge Type 1504.

It consists of a Wheatstone Bridge with two fixed resistors and four input terminals for connection of an external standard and the unknown component. The bridge is operated from a built-in generator. The diagonal voltage is, via a two-stage amplifier, fed to a phase-sensitive demodulator, the output voltage of which is measured on a moving coil instrument with large, interchangeable scales. The scale-reading is the positive and negative deviation in per cent and the postive and negative phase angle in radians between the standard and the unknown component.

Four calibrated, and three blank scales for special calibration purposes are supplied with the Bridge.

Oscillator and Bridge Section.

The oscillator, which is of the Hartley type, operates at a frequency of 1 kc/s. The output voltage is fed to an output amplifier via a resistor or an R-C network. The selection is made by means of the switch marked "Impedance", "Phase Angle". When switched in, the R-C network introduces a 90° phase shift of the output signal.

Via a potentiometer marked "Range Adjustment" the signal is fed to the output amplifier consisting of a pentode. In order to avoid any phase shift being produced in this stage, the load must be true resistive. By paralleling the output transformer with a capacitor and making the transformer tuneable by introducing an adjustable air-space in the iron core, the anode circuit may be adjusted to the bridge frequency, whereby this condition is obtained. This is only true when the secondary load of the transformer is resistive. By a capacitive load (i.e. when measurements are carried out on capacitors) the small extra phase shift causes an error which is corrected for by the table given on page 11. To stabilize the output amplifier this is supplied with negative feedback.

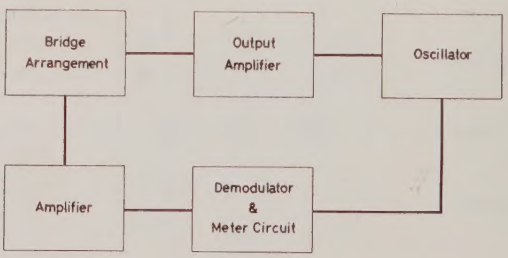


Fig. 2. Block diagram of Type 1504.

The two fixed resistors incorporated in the Wheatstone Bridge are wire-wound resistors of 100 Ω, the mutual point of which is grounded. The two other arms of the bridge are fed to two pairs of terminals marked "Standard" und "Unknown". None of the apparatus terminals are connected to chassis. The upper of the left terminals and the right terminal at the bottom are connected to chassis through resistances of about 100 Ω, having an AC potential of maximum 2 volts with respect to chassis. The other two terminals, marked in white, are mutually connected and led to the input circuit of the amplifier. The bridge arrangement, furthermore, involves a switch marked "R & L", "C", the purpose of which is to interchange the standard and the unknown component. This is to permit direct reading in % deviation of capacity (and not of impedance), and is necessary because the impedance of a capacitor is inversly proportional to the capacity.

Amplifier and Demodulator Section.

Whenever a difference in magnitude or phase angle is present between the standard and the unknown component, a diagonal voltage occurs in the bridge arrangement. This voltage is fed directly to the input of a two-stage resistance-coupled amplifier, which is supplied with negative feedback to obtain a stable operation and a high input impedance. (When measuring too high impedance values, the input impedance of the amplifier will load the bridge, and consequently cause erroneous measurements. See correction curves on p. 23). The output of the amplifier is connected to a demodulation circuit which makes the instrument insensitive to hum and noise voltages to a certain degree, because the demodulator preferably responds to signals of the same frequency as that of the oscillator. Additionally, positive and negative deflections are obtained for positive or negative deviations from the standard, respectively.

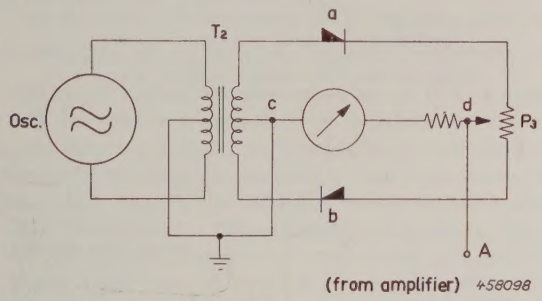


Fig. 3. Principle diagram of the demodulator circuit.

In fig. 3 is shown a basic diagram of the demodulator circuit. It can be seen from the figure that a part of the oscillator voltage is rectified by means of the rectifier cells a and b, and that by adjusting P_3 (marked "Zero Adjustment") a position of the moveable arm of the potentiometer can be found, for which no current will flow through the meter, when no signal is fed to A. Whenever a diagonal voltage occurs in the bridge arrangement, the corresponding amplified signal, with no additional phase shift, is present at A.

If this voltage is in phase with the voltage E_T across the secondary of the transformer T_2 as indicated in Fig. 4 and the rectifier cells a and b are open, only a small current will pass through the meter due to the shunting effect of the rectifiers.

When the cells are blocked the current will flow from c to d, having a magnitude which is much greater than when the cells are open. A DC component of the output voltage from the amplifier will thus be present across the meter, causing this to deflect.

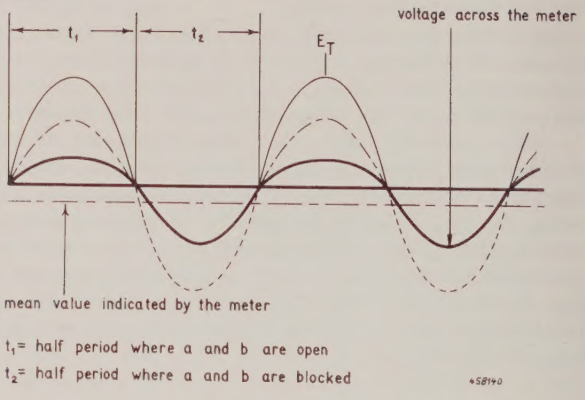

voltage across the meter
t_1
t_2
E_T
mean value indicated by the meter
t_1= half period where a and b are open
t_2= half period where a and b are blocked
*58140

Fig. 4. Operating principle of the phase-sensitive demodulator. Oscillator and bridge output voltage in phase.

If the voltage at A is in antiphase with the voltage E_T across T_2 the sign of the DC component developed across the meter is reversed. This can be seen from fig. 5.

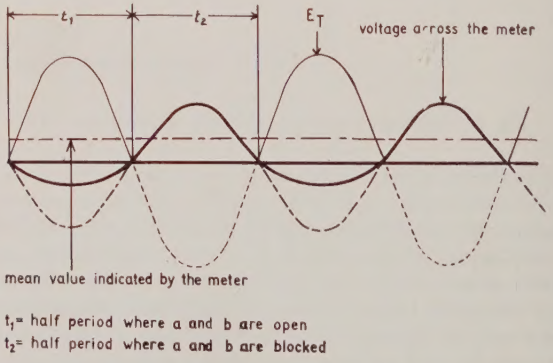

t_1
t_2
E_T
voltage across the meter
mean value indicated by the meter
t_1= half period where a and b are open
t_2= half period where a and b are blocked

Fig. 5. Operating principle of the phase-sensitive demodulator. Oscillator and bridge output voltage in anti-phase.

With the output voltage from the amplifier 90° out of phase, relative to the voltage E_T, the voltage developed across the meter will be as indicated in fig. 6. No DC component is then present, and the deflection on the meter will be zero.

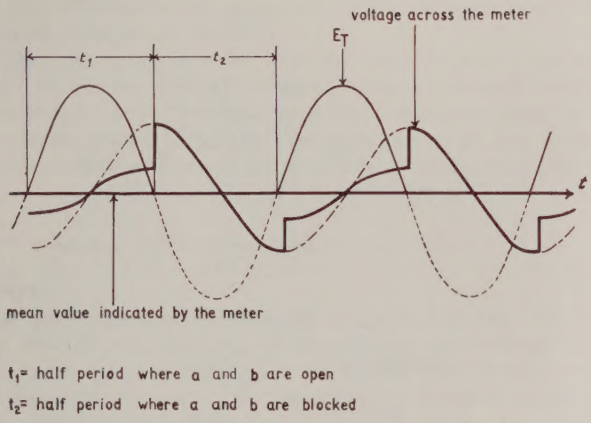

voltage across the meter
E_T
t_1
t_2
t
mean value indicated by the meter
t_1= half period where a and b are open
t_2= half period where a and b are blocked

Fig. 6. Operating principle of the phase sensitive demodulator. Oscillator and bridge output voltage 90° out of phase.

Consequently only the in-phase (or in-antiphase) component of the voltage will be indicated by the meter. By measuring both components, the magnitude as well as the phase angle of the diagonal voltage are determined. With the switch marked "Impedance", "Phase Angle" in position "Impedance", the in-phase (or in-antiphase) component is measured, and with the switch in position "Phase Angle" the 90° out of phase component is indicated. In fig. 7 a vector diagram of the voltages appearing in the Wheatstone Bridge arrangement during measurements is shown.

The vectors AB and BC represent the voltages across the two fixed resistors, respectively, the vectors AD and DC the voltages across the "standard" and the "unknown" impedances respectively, and the vector BD the voltage applied to the amplifier.

When impedance measurements are taken, only the voltage represented by the vector BD_1 is indicated by the meter.

For phase-angle measurements the meter indication will be proportional to the voltage BD_2.

It is seen from the diagram that the point D might move along a line drawn through the points $D - D_1$ without influencing the magnitude of the vector BD_1.

Analogously the magnitude of the vector BD_2 will not be influenced if the point D moves along a line drawn through the points $D - D_2$.

As the difference in phase angle between the "standard" and the "unknown" is α (see fig. 7) this means that:

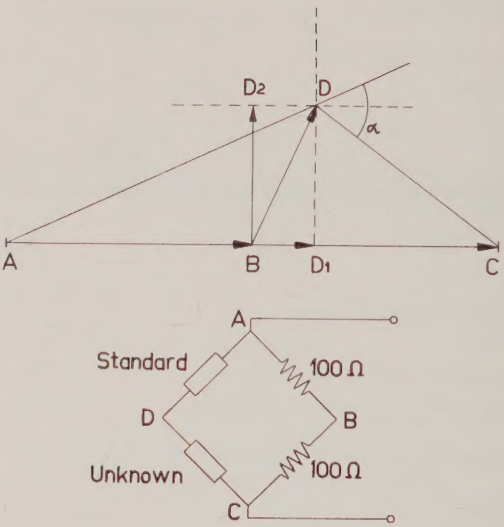


Fig. 7. Vector diagram of bridge voltages.

1. When the phase angle of the "unknown" is very much different from the phase angle of the "standard" the measurement of impedance deviation is inaccurate.
2. When the impedance of the "unknown" is very much different from the impedance of the "standard" the measurement of phase angle deviation will be inaccurate.

The maximum inaccuracy will be present when both phase angle and impedance measurements show maximum deviation between "standard" and "unknown".

Meter Section.

As previously mentioned, different dials can be inserted in the large square-type indicating meter.

The four calibrated scales, supplied with the instrument cover the following ranges of deviation measurements:

Impedance Deviation	*Phase Angle Deviation(tan δ)*	*Range Adjustment*
— 1.5 % to + 1.6 %	— 1.5 to + 1.5 $\times 10^{-2}$	1 %
— 7 % to + 8 %	— 7 to + 7 $\times 10^{-2}$	5 %
— 25 % to + 35 %	— 30 to + 30 $\times 10^{-2}$	20 %
— 50 % to + 100 %	— 80 to + 80 $\times 10^{-2}$	20 %

The moving coil instrument is slightly under-critically damped to secure maximum speed, and is perfectly protected against overload.

To be able to calibrate the apparatus for the different ranges in a quick way reference voltages are provided.

When the 1 % range is to be used the range switch is set to position "Ref. 1 %". By turning the knob marked "Range Adjustment" until the meter pointer deflects to the red mark on the scale, a voltage is applied to the input of the amplifier, with a magnitude corresponding to the one obtained when the impedance deviation between the standard and unknown impedance is 1 %.

Reference voltages for the 5 %, 20 % and the 100 % ranges are also available.

Power Supply.

The European model is intended for use with 115, 127, 150, 220 or 240 volts AC, 40—400 c/s. Switching to the different line voltages is made by means of a screwdriver through a hole in the back plate. A pilot disc indicates the line voltage to be connected. The American model is designed for 115 volts, 60 c/s. The power consumption for both models is about 40 watts. The plate voltage to the oscillator is stabilized by a neon tube. A variation of 10 % in the power supply voltage will influence the meter deflection by less than 3 %, the zero point being independent of the line voltage.

Operation.

General Remarks.

During measurements it is advantageous to ground the apparatus. The standard and the objects to be measured should be placed together with the bridge on a grounded metal plate.

If the object to be tested is grounded, the grounded pole should be connected to the right "Unknown" terminal, and the grounding of the cabinet be omitted. The capacity of the apparatus to ground is then connected across one of the built-in ratio resistors and should consequently be kept as low as possible.

When high impedances are being measured (large resistors and inductances, and small capacitors, respectively) the connections to the bridge should be taken into account.

In addition no extra capacity must be introduced between chassis and the two terminals marked in white.

Operation Procedure.

1. Make sure that the Deviation Bridge is adjusted to the correct mains voltage. If not turn the pilot disc on the rear panel of the instrument to the desired voltage (115 — 127 — 150 — 220 or 240 volt).
2. Connect the power cable to the mains and place the toggle switch marked "Power" in position "On". The light on the meter comes on immediately.
3. Allow a few minutes warm-up time.
4. Set the switch marked "Impedance"/"Phase Angle" in position "Impedance".
5. Place the meter scale corresponding to the desired measuring range (1 %, 5 %, 20 % or 100 %) in the meter frame. (The scale is removed from the frame by pulling to the right).
6. Turn the operation switch (knob to the left) to "Zero". By means of the knob marked "Zero Adjustment" the meter pointer is set to 0.
7. Connect the standard component to the terminals marked "Standard" and the component to be checked to the terminals "Unknown".
8. Set the operation switch to the desired Ref. value ("Ref. 1 %", "Ref. 5 %" "Ref. 20 %"). Turn the knob marked "Range Adjustment" until the meter pointer is on the red mark on the scale.

Note:

When measuring high impedances, the values obtained from the adjustment curves, shown on p. 23, should be used for the range adjustments, instead of the red mark on the scale.

9. Turn the "Component Selector" to the correct position for resistors and inductances in position "R & L" and for capacitors in position "C". For the influence of capacitive loading see Table 1 below.
10. Turn the operation switch to position "Operation" and the instrument is ready for use.
11. For *phase angle measurements* set the switch marked "Impedance" "Phase Angle" in position "Phase Angle". It is locked in this position by pushing it downwards and to the left.
    Note:
    To avoid overloading of the amplifier a check should be made that the meter deflection is kept within full scale deflection both with the press button switch in position "Impedance", and in position "Phase Angle".
12. The components to be tested are now successively connected to the two terminals marked "Unknown" and the meter deflection will give the deviation from the Standard directly in %.

Deflection to the right means positive deviation (unknown bigger than Standard), and deflection to the left negative deviation (unknown smaller than Standard).

20 %	Impedance accuracy	0.01 b	for capacities up to 1 µF
		0.02 b	at 10 µF
	Phase angle accuracy	0.01 a	for capacities up to 10 µF
5 %	Impedance accuracy	0.02 b	for capacitites up to 0.5 µF
		0.05 b	at 3 µF
		0.12 b	at 10 µF
	Phase angle accuracy	0.02 a	for capacities up to 3 µF
		0.05 a	at 7 µF
		0.07 a	at 10 µF
1 %	Impedance accuracy	0.07 b	for capacitites up to 0.5 µF
		0.12 b	at 5 µF
		0.16 b	at 10 µF
	Phase angle accuracy	0.04 a	for capacitites up to 0.5 µF
		0.07 a	at 5 µF
		0.14 a	at 10 µF

Table 1. The extra inaccuracy which is introduced when measurements are carried out on capacitors. With an impedance deviation reading of a % and a phase angle deviation reading of b % the inaccuracy on the 3 different % ranges are directly found.

Accessories.

Test Jig Type 3902.

The Test Jig Type 3902 is designed to be used in conjunction with the Deviation Bridge for rapid production control of resistors, capacitors, and inductances. It consists of a wooden board on which the Deviation Bridge should be placed. On the board in front of the instrument are placed two posts which are designed with spring loaded-contacts. The opening of the

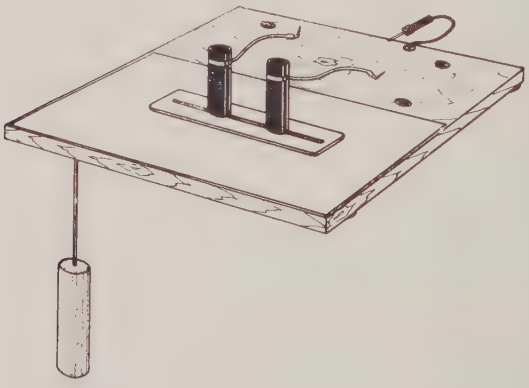


Fig. 8. Drawing of the Test Jig Type 3902.

contacts is controlled by means of a lever, and the contacts can be directly connected to the terminals marked "Unknown". The lever is intended to be operated by means of the operators left knee. That part of the wooden board which is in front of the instrument is, in addition, supplied with a steel plate. This may be connected to the instrument cover or to ground. The distance between the posts is adjustable to any spacing between 0 and 14 cm (5½ inch.). The measurements are carried out by engaging the lever for operating the silver contacts, placing the component to be measured between the two posts, and releasing the lever. The instrument then immediately shows the deviation from the standard-component employed.

Applications.

Measurement of Resistors and Capacitors in Laboratories.

In laboratories where resistors and capacitors are frequently measured, it will be a practical advantage to set up a couple of measuring bridges of type 1504 permanently connected to the resistor and capacitor standard, as indicated in fig 9.

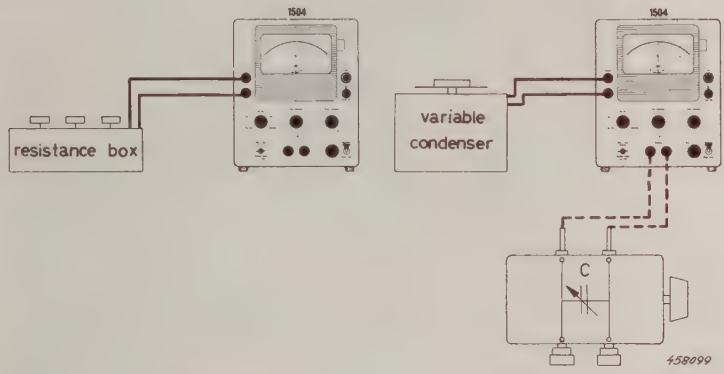


Fig. 9. Resistance box and variable condenser connected to Deviation Bridge type 1504.

Resistors are measured on the 1504; the "Unknown" being connected to the Bridge, and the standard resistor being varied until the bridge is balanced. The unknown resistance can then be immediately found by reading off the value on the resistance box. This form of resistance measurement is much quicker in practice than adjusting a Wheatstone Bridge, because the meter of 1504 responds much quicker than the usual light-spot galvanometer.

Capacitors may also be measured on the 1504 in exactly the same way. In order to compensate for the connections to the variable condenser and its minimum capacity, the unknown capacitor should be connected via a small extra measuring box, containing a balancing capacity. In this way, a quick and very exact measurement of small capacitors can be carried out.

Checking of Coils for Short-Circuit Turns.

For checking coils in transformers, chokes, inductances etc., a set-up as indicated in fig. 10 is very useful. Two identical measuring coils with long iron cores are balanced on the bridge, and the coil under test is then placed over the end of one of the cores.

If there is a short-circuit in the coil, the induction in the coil will react with the balanced coil, and deflect the meter pointer. In most cases a phase angle measurement will give the highest sensitivity.

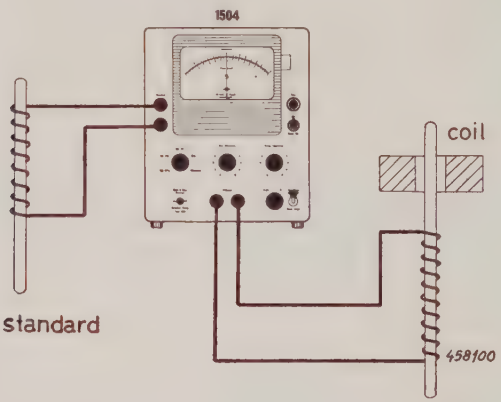


Fig. 10. Checking of coils.

Balance of Ganged Variable Potentiometers.

For adjustment of coupled variable potentiometers the set-up shown in fig. 11 will be practical. The two end terminals are connected respectively to the upper left and lower right terminals of the bridge, while the moveable arms may be connected together and joined to one of the two remaining terminals. The balance expressed in % deviation may then be checked for all positions of the moveable arm.

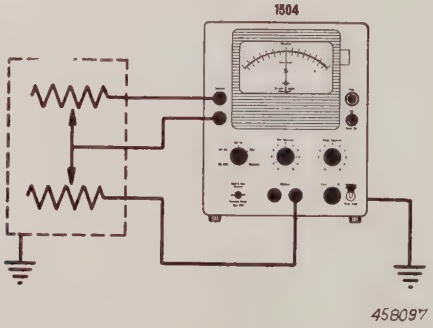


Fig. 11. Matching of potentiometers.

Checking of Transformers.

The Deviation Bridge is also a suitable apparatus for checking transformers for amplifiers, hearing aids, etc. The set-up is shown in fig. 12. The transformer with its correct load on the output side is connected to the terminals marked "Unknown". A perfect transformer loaded with the same impedance is used as the standard, and defects in either coils, turn numbers or laminations may then be observed. When measuring high-impedance transformers it may happen that the capacity is so high that it will disturb the measurements. Such transformers have to be measured at a very low frequency (1503).

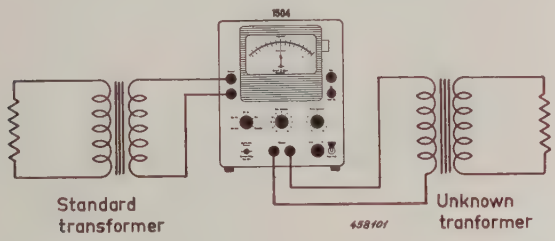


Fig. 12. Production testing of transformers.

Direct-Reading Measurements of Capacitances.

The Deviation Bridge type 1504 may be used as a direct-reading instrument for measuring capacitances. Two equal condensers of exactly known capacitances are, as shown in fig. 13, connected across the "Standard" and "Unknown" terminals, one to each terminal. The capacitance to be found is measured as a per cent increase of the fixed known value. By choosing the fixed condensers as pure powers of 10 the direct readings will be simplified.

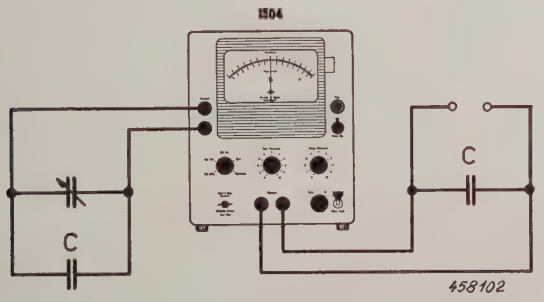


Fig. 13. Direct reading measurements of capacity values.

To make the adjustment easier it will be practical to have part of the capacitance on "Standard" placed as a small trimmer condenser.

Direct-Reading Measurements of Resistances.

In a similar way as for capacitances it is possible to use the Deviation Bridge as a direct-reading ohmmeter. As illustrated in fig. 14 two fixed resistors have to be used, but the resistance under test has to be connected in series with one of the fixed resistances. The small adjustable fraction of the other fixed R may be connected either in series or in parallel with R. If a series connection is used, the adjustable R need only be a few per cent of the total value of the fixed resistance, while it has to be great compared to the total resistance if connected in parallel.

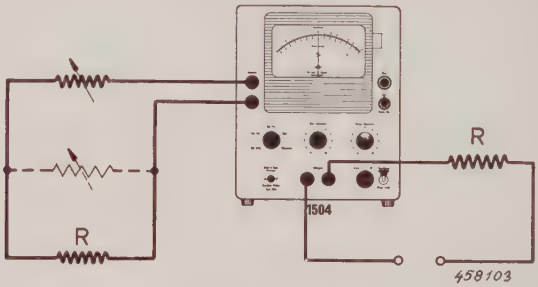


Fig. 14. Direct reading measurements of resistance values.

Loss in capacitors.

Most paper condensers have a tan δ of approx. 1 %. The loss can easily be measured with the bridge on its $\pm$ 1.5 % range, provided that the standard has negligible loss and the capacity of the measuring object is also within that deviation from the capacity of the standard. If the paper condensers are only within the usual tolerance of $\pm$ 10 %, the bridge must be set to impedance measurement, and the standard condenser adjusted to give 0 reading on the meter. After that, the swich is depressed to phase angle measurements and the tan δ is read off the scale. The loss of high-K ceramic condensers will also be within the range of the bridge, whereas the loss in low-K ceramic and polystyrene condensers is too small to be measured by this method.

Adjustment of L and Q for Inductors.

A standard inductor is used as the standard, and the measuring object is connected to the "Unknown" terminals. With the switch on "Impedance" the inductance is adjusted to give zero reading. The switch is then set to "Phase

Angle" and the Q of the inductor is adjusted (with series or parallel resistors or by some other appropriate method) to give 0 phase angle deviation. In some cases the L and Q adjustments are not independent of each other and the procedure should be repeated to give the best results.

Checking a Tube's Transconductance and Internal Resistance.

For many applications, for example d.c. amplifier, scaling units for calculating machines, and so on, it is important that those tubes which are employed in the construction have definite values with narrow tolerances

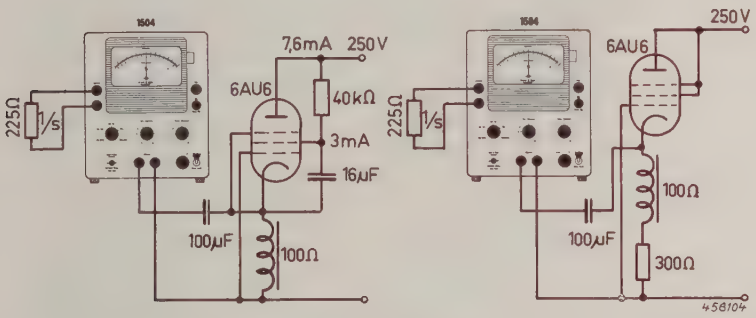


Fig. 15. Measuring transconductance of 6AU6 tube connected respectively as pentode and triode.

for both transconductance and internal resistance. The Deviation Bridge Type 1504 will also here give complete satisfaction in the control and choice of suitable tubes.

Fig. 15 shows a typical set-up for measuring a tube's transconductance, the tube being connected respectively as pentode and triode. The indicated resistance values are applicable for tube type 6AU6.

If other tube types have to be measured, the components as shown in the diagram must naturally be changed in value to suit. It is important that the choke coil shown in the cathode lead of the diagram has an impedance which is great in relation to the tube's reciprocal transconductance at the measuring frequency of 1000 c/s. In the same way, the impedance of the coupling condenser which connects the tube set-up to the bridge (the 100 μF condenser in the diagram) should have a value which is small in relation to the reciprocal transconductance. By choosing as standard resistor a value of 225 Ω, the bridge pointer will indicate 0 if the 6AU6 tube has the transconductance given in the catalogue.

Fig. 16 shows the corresponding set-up for measuring a tube's internal resistance, and here it is important that the impedance in the tube's anode circuit should be much greater that the tube's internal resistance. Therefore. when the tube is connected up as a pentode, it is expedient to produce resonance in the anode impedance.

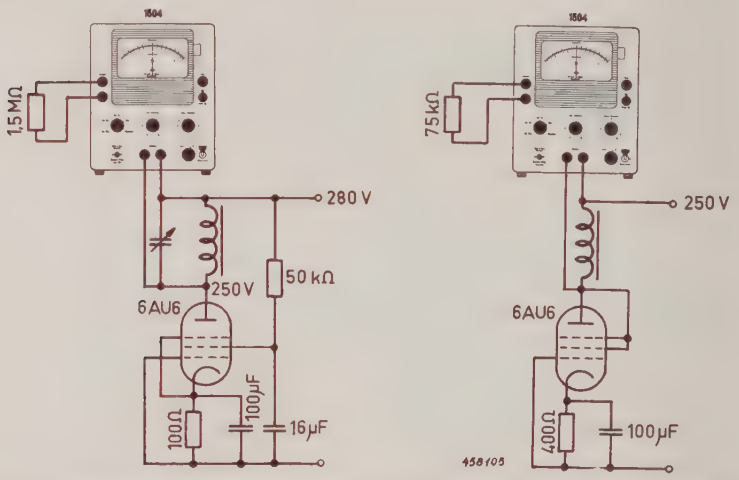


Fig. 16. Measuring internal resistance of 6AU6 tube connected respectively as pentode and triode.

Checking of Focusing Magnets for TV.

Fig. 17 shows a set-up for testing the homogenity in the magnetic field around an axial-magnetized, ring-shaped magnet.

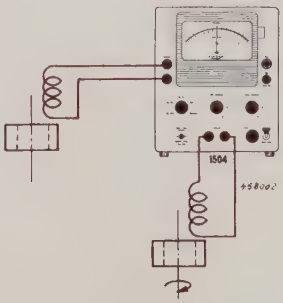


Fig 17. Set-up for checking focusing magnets for TV sets.

To the "Standard" and the "Unknown" terminals are connected two identical coils. In front of one of the coils with its axis parallel to that of the coil but displaced by half a ring-diameter the ring is rotated. Any change in the meter deflection of the 1504 is then due to a non-homogenity in the magnetic field.

Tube No.	Per Cent Deviation of Transconductance								Per Cent Deviation of Internal Resistance							
	HYTRON	MAZDA A	PHILIPS	RCA	SYLVANIA	TUNGSRAM	MAZDA B	G. E.	HYTRON	MAZDA A	PHILIPS	RCA	SYLVANIA	TUNGSRAM	MAZDA B	G. E.
1.	+10%	+ 8%	+ 4%	÷ 3%	+ 5%	+ 4%	+10%	÷12%	÷14%	÷17%	+ 3%	÷23%	÷25%	÷13%	÷10%	÷ 4%
2.	+ 7%	+11%	+ 7%	+ 3%	+ 2%	÷ 1%	+ 7%	÷ 6%	÷17%	÷ 6%	+10%	÷25%	÷25%	÷ 3%	÷ 9%	÷ 8%
3.	+ 9%	+ 8%	+ 7%	÷ 5%	÷ 1%	0	0	0	÷10%	+ 5%	÷15%	÷25%	÷25%	÷11%	÷ 1%	÷21%
4.	+ 3%	+15%	0	÷ 1%	÷10%	÷ 9%	+11%	+ 8%	÷11%	÷ 1%	÷ 1%	÷25%	÷25%	÷ 9%	÷12%	÷10%
5.	+ 9%	+16%	+ 6%	÷ 3%		+ 4%	+ 8%	÷ 2%	÷10%	÷10%	+15%	÷25%		÷13%	÷ 8%	÷ 5%
6.	+16%	+15%	+ 2%	+ 7%		+ 2%	+ 7%	+ 8%	÷14%	÷11%	+ 9%	÷25%		÷11%	÷ 5%	÷25%
7.	+ 2%	+ 2%	+10%			+ 8%	+15%	+ 1%	÷14%	÷ 4%	+ 1%			÷20%	÷ 7%	÷18%
8.	+13%	+ 8%	÷ 1%			÷ 1%	+ 3%		÷25%	÷17%	0			÷12%	÷ 9%	
9.	+15%	+ 8%	÷ 2%			+ 2%	+10%		÷16%	÷ 2%	+ 5%			÷11%	÷13%	
10.	+14%		÷ 5%			÷ 2%			÷ 9%		+ 5%			÷12%		
Average	+ 9.8%	+10.1%	÷ 2.8%	÷ 0.3%	÷ 1%	+ 0.7%	+ 7.9%	÷0.43%	÷ 14%	÷ 7%	+ 3.2%	÷24.7%	÷25%	11.5%	÷ 8.2%	÷13%

Table II. Examples of measurements of internal resistance and transconductance of 6AU6 tube connected as pentode.

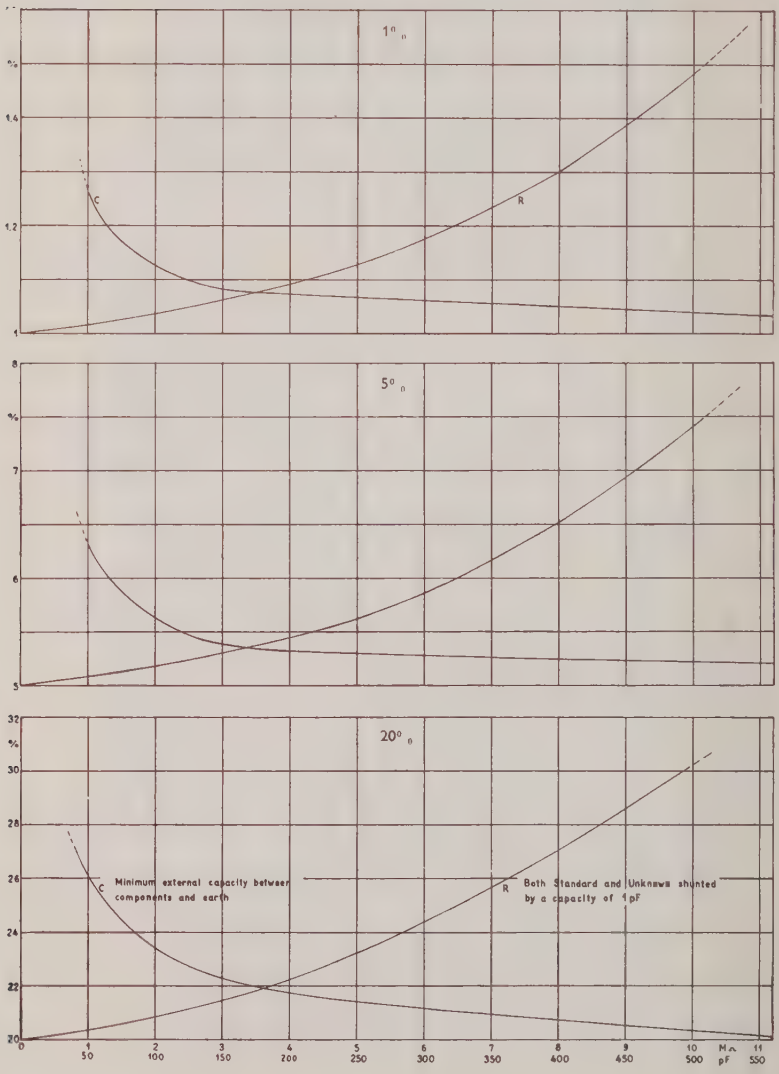
Tube No.	Per Cent Deviation of Transconductance								Per Cent Deviation of Internal Resistance							
	HYTRON	MAZDA A	PHILIPS	RCA	SYLVANIA	TUNGSRAM	MAZDA B	G. E.	HYTRON	MAZDA A	PHILIPS	RCA	SYLVANIA	TUNGSRAM	MAZDA B	G. E.
1.	+25%	+26%	+19%	+ 8%	+22%	+23%	+23%	+ 4%	÷ 4%	÷ 9%	+ 5%	+17%	+ 8%	÷11%	÷18%	+22%
2.	+20%	+20%	+23%	+18%	+21%	+16%	+24%	+12%	+ 3%	÷ 7%	÷ 6%	÷ 1%	+ 4%	÷ 3%	÷16%	+ 3%
3.	+23%	+25%	+27%	+ 8%	+17%	+19%	+ 8%	+17%	÷ 5%	÷ 9%	÷12%	+20%	+ 4%	÷ 5%	0	÷ 5%
4.	+19%	+26%	+20%	+14%	+ 9%	+15%	+25%	+20%	+ 7%	÷14%	÷ 1%	+ 5%	+15%	÷ 6%	÷15%	÷ 5%
5.	+23%	÷26%	+17%	+ 8%		+27%	+25%	+18%	+ 9%	÷16%	+ 8%	+ 9%		÷10%	÷15%	÷ 5%
6.	+31%	+29%	+18%	+23%		+25%	+22%	+18%	÷ 9%	÷13%	+ 4%	+ 3%		÷13%	÷11%	÷ 4%
7.	+19%	+16%	+22%			+30%	+29%	+21%	+ 7%	÷15%	+ 1%			÷11%	÷13%	0
8.	+26%	+27%	+21%			+21%	+22%		÷ 1%	÷12%	0			÷ 9%	÷ 9%	
9.	+28%	+22%	+13%			+23%	+24%		+ 3%	÷10%	+ 9%			÷ 9%	÷14%	
10.	+19%		+10%			+22%			+ 7%		+14%			÷ 9%		
Average	+23.3%	+18.3%	+19%	+13.2%	+17.2%	+22.1%	+22.4%	+15.7%	+ 1.7%	÷10.5%	+ 2.2%	+ 8.8%	+ 7.7%	+ 8.6%	+11.1%	+ 0.8%

Table III. Examples of measurements of internal resistance and transconductance of 6AU6 tube connected as triode.

Corrections Curves for Reference Point Adjustment

Valid for instruments with serial number 15100 and upwards

Type 1504



Specification.

Ranges of Test Components for Deviation Measurements:

Resistance: 10 Ω—10 MΩ
Capacitance: 50 pF—10 μF
Inductance: 2 mH—100 H

Ranges of Test Components with Two External Standards and Direct Reading:

Resistance Range from 0—0.15 Ω to 0—3.5 MΩ
Capacitance Range from 0—1.5 pF to 0—3.5 μF

Measurement Frequency: 1000 c/s.

Meter: Large moving-coil instrument in which removeable scales can be inserted (see figure). Illuminated scale with zero point in the centre. The instrument is safeguarded against overloads. Ranges for impedance deviations from $-1.5\ \%$ to $+1.5\ \%$, $-7\ \%$ to $+8\ \%$, $-25\ \%$ to $+35\ \%$ and $-50\ \%$ to $+100\ \%$ and for phase angle deviations from -1.5 to $+1.5 \times 10^{-2}$, -7 to $+7 \times 10^{-2}$, -30 to $+30 \times 10^{-2}$ and -80 to $+80 \times 10^{-2}$ radians.

Accuracy of impedance measurements: Better han 0.03 % for deviations close to zero. With zero phase angle difference of standard and unknown: Better than 3 % of indicated deviation at full-scale deflection.

Stability: The zero point is independent of the line voltage. Deflections from the zero point will change 3 % for a 10 % variation of line voltage.

AC-Hum: The bridge is not sensitive to hum voltages.

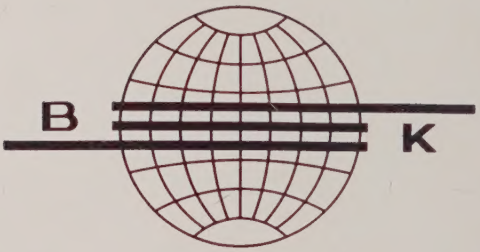
Impedance — Phase Angle Switch: A special microswitch is included to allow speedy switching from impedance to phase angle measurements.

Tubes: 3×6AU6 (EF94), 6AQ5 (EL90), 6X4 (EZ90), OA2 (150C2).

Power Supply: 115—127—150—220—240 Volts AC. 40—400 c/s. 40 Watts.

Dimensions: 33 (height) × 28 (width) × 20.5 (depth) excl. dials cm.
13 (height) × 11 (width) × 8 (depth) excl. dials inch.

Weight: 10 kg (22 lbs.)



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